Health Consultation

WASHINGTON COUNTY LEAD DISTRICT
WASHINGTON COUNTY, MISSOURI

EPA FACILITY ID: MON000705023
EPA FACILITY ID: MON000705027
EPA FACILITY ID: MON000705032

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U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Agency for Toxic Substances and Disease Registry
Division of Health Assessment and Consultation
Atlanta, Georgia 30333

Health Consultation: A Note of Explanation

An ATSDR health consultation is a verbal or written response from ATSDR to a specific request for information about health risks related to a specific site, a chemical release, or the presence of hazardous material. In order to prevent or mitigate exposures, a consultation may lead to specific actions, such as restricting use of or replacing water supplies; intensifying environmental sampling; restricting site access; or removing the contaminated material.

In addition, consultations may recommend additional public health actions, such as conducting health surveillance activities to evaluate exposure or trends in adverse health outcomes; conducting biological indicators of exposure studies to assess exposure; and providing health education for health care providers and community members. This concludes the health consultation process for this site, unless additional information is obtained by ATSDR which, in the Agency's opinion, indicates a need to revise or append the conclusions previously issued.

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Prepared By:

Missouri Department of Health and Senior Services
Division of Community Health
Section for Disease Control and Environmental Epidemiology
Bureau of Environmental Epidemiology
Under cooperative agreement with the
The Agency for Toxic Substances and Disease Registry

STATEMENT OF ISSUES AND BACKGROUND

Statement of Issues

The Missouri Department of Natural Resources (MDNR) requested that the Missouri Department of Health and Senior Services (DHSS), in conjunction with the federal Agency for Toxic Substances and Disease Registry (ATSDR), complete a health consultation to evaluate the potential risk of adverse health effects for residents who are exposed to lead and other mining-related heavy metal contamination in Washington County, Missouri. Currently, the U.S. Environmental Protection Agency (EPA) is investigating three separate study areas in Washington County called the Potosi, Old Mines, and Richwoods Site Areas. See Figure 1. This health consultation will evaluate data from all three of these operable units, and assess exposure to lead and other mining-related contaminants in soil and drinking water.

Background

Missouri has a rich history of lead mining dating back to the 1700s. Mining began along the Meramac River and in the St. Francois Mountains in the southeast part of the state, and then expanded throughout the southern half of the state as new lead deposits were discovered (1). Lead mining continued in Washington County until around the end of the American Civil War as lead deposits in Washington County decreased and demand for lead declined (2). The majority of lead mining in Washington County to this point was surface and shaft mining.

Around the same time the lead industry declined, more uses for barium were being discovered, and the barium industry was growing. In Washington County, barium sulfate, called barite or "tiff", had previously been a discarded waste product from lead mining, but it became a valuable resource around the end of the American Civil War. It did not take long for lead mining to be replaced by barite mining, and many of the once abandoned lead mines in the county were mined again for barite. It is expected that much of this mining was surface mining using machinery as it became available. By 1941, Missouri accounted for 40 percent of barite production in the United States. (2)

During the lead and barite mining, milling and smelting processes, large quantities of lead-containing waste products were generated and deposited on the surface. Because of these processes and the resulting waste products, sites where these activities took place often have lead concentrations substantially greater than the background concentrations for the area. Studies have shown that residential exposure to mining, milling and smelting wastes around these locations is related to an unacceptably high percentage of children with elevated blood lead levels (3, 4).

For the past several years, the Missouri Department of Natural Resources (MDNR) has been conducting a statewide inventory of lead mining, milling and smelting sites in Missouri. Because of its mining history, Washington County was one of the first counties to be investigated in southeast Missouri. According to the MDNR's Inventory of Mines, Occurrences and Prospects database, approximately 1,059 historical mining sites are located in Washington County.

MDNR began by sampling public areas, such as parks, daycare facilities, and schoolyards around the town of Potosi in Washington County. In-situ X-Ray Florescence (XRF) analyses indicated the presence of lead in the surface soil at 30 public properties in Washington County. The lead concentrations detected by the XRF ranged from 14 parts per million (ppm) to 1,330 ppm. Ten of these locations had lead concentrations above 400 ppm, six of which were above 1,200 ppm.

Beginning in June 2005, MDNR and EPA staff collected soil samples and private drinking water well samples from residential properties and lead mining source areas in Washington County. As of May 2007, the focus of sampling efforts has been within three areas of Washington County named the Potosi Area, Old Mines Area, and Richwoods Area. See Figure 1. Most of the residential properties within these areas have been sampled; however, there are a few residential properties that EPA has not been able to obtain permission to sample.

As of May 2007, EPA had tested over 1,500 private wells in the Potosi, Old Mines, and Richwoods Areas. Water sampling results were compared to EPA's site-specific drinking water action level for lead of 15 micrograms per liter (μg/L). This level is typically used by public water systems to trigger treatment of public water supplies when exceeded. EPA is currently using this site-specific action level in Washington County as a guideline to provide alternative sources of water to private well users. Analytical results from the water samples indicate that approximately 272 wells out of the 1,500 tested contained lead above EPA's site-specific action level. See Table 1.

Table 1. Water Sampling Results (as of May 2007)*

Total Number of Private Wells Sampled	1,500
Number of Wells Above EPA's Action Levels for Lead	272

*Values are approximations.

As of May 2007, EPA had tested the soil in over 2,600 residential yards in Washington County. Most of these residential yards have been within the three EPA's designated operable units shown in Figure 1. Soil sample results were compared to EPA's standard cleanup value of 400 ppm and time critical action level for the Washington County sites of 1,200 ppm lead. See Lead Cleanup for Soil under the Toxicological Evaluation section for an explanation of cleanup levels and action level. Results of the soil testing found 212 residential yards with concentrations of lead above 1,200 ppm and 750 residential yards with concentrations of lead between 400 ppm and 1,200 ppm. See Table 2.

Table 2. Soil Sampling Results (as of May 2007)*

Total Number of Residential Yards Sampled	2,600
Yards with Lead Below 400 ppm	1,640
Yards with Lead Between 400-1,200 ppm	750
Yards with Lead Above 1,200 ppm	210

ppm = parts per million

*Values are approximations.

Approximately 400 soil samples were collected in residential yards in the Potosi Area of Washington County to test for barium and arsenic. The concentrations of barium and arsenic found in these samples were compared to ATSDR's Reference Dose Media Evaluation Guide (RMEG) and Environmental Media Evaluation Guide (EMEG). RMEGs are comparison values (CVs) that represent concentrations that are unlikely to result in adverse noncarcinogenic health effects for daily exposures based on EPA's oral reference doses. EMEGs are CVs that estimate concentrations that are not expected to cause adverse noncarcinogenic health effects based on ATSDR's Minimal Risk Levels (MRLs) and conservative assumptions about exposures. Concentrations above CVs do not necessarily indicate that a health threat is present, but that further evaluation of the chemical and pathway is needed.

Out of the 400 soil samples tested for barium and arsenic, 100 of the samples had concentrations of arsenic above the RMEG for children with the average concentration being 16 ppm and the maximum concentration being 138 ppm. Barium was found in one sample at a concentration above the RMEG for children. The average concentration of barium found was 2,730 ppm and the maximum concentration was 10,500 ppm. See Table 3. Background concentrations for soil given by U.S. Geological Survey (USGS) PLUTO database in 2005 for Washington County were 26.3 ppm for arsenic and 3863 ppm for barium (5).

Table 3. Soil Sampling Results, Comparison Values and Background Concentrations for Arsenic and Barium

Chemical Name	Maximum concentration (ppm)	Average concentration (ppm)	Child RMEG (ppm)	Pica child EMEG (ppm)	Background concentration (ppm)
Arsenic	138	16	20		26.3
Barium	10,500	2,730	10,000	1,000	3,863

RMEG = ATSDR's Reference Dose Media Evaluation Guide are comparison values that represent concentrations that are unlikely to result in adverse noncarcinogenic health effects for daily exposures based on EPA's oral reference doses.
EMEG = ATSDR's Environmental Media Evaluation Guide are comparison values that estimate concentrations that are not expected to cause adverse noncarcinogenic health effects based on ATSDR's Minimal Risk Levels and conservative assumptions about exposure.
ppm = parts per million

As of September 2006, about 190 samples private wells had been tested for barium and cadmium in addition to lead. The concentration of barium and cadmium detected in these wells were compared to EPA's Maximum Contaminant Levels (MCLs), which are the highest concentrations of a contaminant that EPA will allow in a public drinking water supply. Three of the wells had barium concentrations above MCLs with an average concentration of barium of 589 μg/L and a maximum of 2230 μg/L. One well had a cadmium concentration of 5.73 μg/L, which is slightly above MCL. See Table 4.

Table 4. Private Water Sampling Results for Barium and Cadmium.

Chemical Name	Maximum concentration (μg/L)	Average concentration (μg/L)	MCL (μg/L)	Numbers of wells above MCL
Barium	2230	589	2000	3
Cadmium	5.73	2.1	5	1

MCL = EPA's Maximum Contaminant Level is the highest concentration of a contaminant that EPA allows in a public water system.
μg/L = micrograms per liter

DISCUSSION

To determine whether residents of the area have been or are being exposed to contaminants in Washington County, DHSS evaluated the environmental and human components that lead to an exposure pathway. Completed exposure pathways exist when all five elements of a pathway link the contaminant source to a receptor population. Potential exposure pathways exist if at least one of the five elements is missing or uncertain, but could exist. An exposure pathway can be eliminated if at least one of the five elements is missing and will never be present. Completed and potential exposure pathways could have been present in the past, could be present currently, or could be present in the future (6).

1. **Contaminant source** – tailings piles, formerly mined areas and exposed ore in abandoned mines.
2. **Environmental medium and transport** – contaminated water and soil.
3. **Point of exposure** – private drinking wells, soil, and surface waters.
4. **Route of exposure** – ingestion and inhalation.
5. **Receptor population** – residents, private well users and those who inhaled contaminated dust or ingested contaminated soil or surface water.

In Washington County, MDNR and EPA have collected soil samples from public properties such as parks and schools, and from residential yards and non-residential source areas. They have also collected drinking water samples from residences with private wells. Elevated concentrations of lead have been found in soils in public areas and residential yards, and some private drinking water wells in many parts of Washington County. Over 35% of the properties tested have had lead concentrations above 400 ppm in soil. In addition, 18% of the private wells sampled had lead concentrations above EPA's site-specific action level of 15 μg/L. EPA is providing bottled water to residents with contaminated private wells and remediating residential yards that contain soil with lead concentrations above action levels. However, some residents have refused EPA's assistance. Further investigation is needed to determine the extent of lead contamination in the county outside of the EPA's Potosi, Old Mines, and Richwood Area operable units.

Lead contamination in residential soil and water can be especially harmful for children. Because of their habits, children are more likely to become exposed to contaminants in soil or water. Children have a tendency to have frequent hand-to-mouth contact and introduce non-food items into their mouths. While playing in lead contaminated residential yard soils, children could

incidentally ingest contaminated soil particles or inhale contaminated dust, which puts them at risk for elevated blood lead levels and adverse health effects. Exposure to the contaminated water could occur by drinking it or other beverages made with the contaminated water or by incidental ingestion while bathing or playing.

Because residential exposure to lead contamination has been correlated with elevated blood lead levels in children, regional ATSDR staff, DHSS, and the Washington County Health Department collaborated with MDNR and EPA to encourage blood lead testing. In 2001, 20 % of the children less than 72 months of age were tested. In 2002, 23% were tested, and in 2003 and 2004, 19% were tested. In 2005, the number of children tested increased to 23% with 5% of the children tested having elevated blood lead levels. 25% of children in Washington County were tested for blood lead in 2006 with 5.6% having elevated levels of blood lead compared to 2.2% of children tested with elevated blood lead levels statewide in 2006. Currently, the Washington County Health Department is providing blood lead testing for free to Washington County residents. Regional ATSDR staff, DHSS, and the Washington County Health Department has also provided free blood lead testing at some public meetings held in the area. Further testing is needed to determine to what extent remediation efforts and health education provided to the community has affected the children that reside there.

Barium, and cadmium have also been detected in some private drinking water wells in Washington County. Barium has been found in 3 private wells above the MCL, and cadmium has been found in 1 private well above the MCL. However, barium and cadmium contamination in water does not appear to be widespread in Washington County.

Concentrations of arsenic and barium in some soil samples collected in the Potosi Area of Washington County were above CVs. However, finding concentrations above CVs does not mean that adverse health effects will occur, but it does mean that further investigation is needed. Further investigation of the soil sample data currently available shows the concentrations of arsenic and barium detected by EPA sampling in Washington County is less than the average background concentration for Washington County. An average background concentration is the concentration predicted to be occurring naturally in the soil in a specific area, which in this case is Washington County (5).

Concentration values given in this health consultation for arsenic and barium reflect only a single soil sample from yards. Because individuals typically do not spend their time in one location in a yard, average yard concentrations based on several yards samples would provide a more accurate exposure calculation, but more sampling data would be needed to do this. However, of the 20 samples with the highest concentrations of arsenic detected, 19 had concentrations of lead above EPA's standard cleanup value. Therefore, since lead is the chemical of most health concern in Washington County, it is likely, that by remediating the yards contaminated with lead, most of the higher concentrations of arsenic detected would be removed.

TOXICOLOGICAL EVALUATION

This section will discuss the potential adverse health effects of exposure to arsenic, barium, cadmium, and lead. Non-cancerous health effects and the likelihood of the contaminant causing cancer will be evaluated.

ATSDR has developed Minimal Risk Levels (MRLs) that are an estimate of daily human exposure to a hazardous substance that is likely to have an adverse noncancer health effect over specified exposure duration. Similarly, EPA has developed Reference Doses (RfDs) that estimate the daily lifetime dose of a substance that is unlikely to cause harm in humans. Health assessors use MRLs, RfDs, and CVs, such as EMEGs and RMEGs, which are media-specific concentrations to select environmental contaminants of concern. Contaminant concentrations that are less than these values are unlikely to pose a health threat. Contaminant concentrations above MRLs, RfDs, and CVs do not necessarily indicate that a health threat is present, but that further evaluation of the chemical and pathways is needed.

Arsenic

Arsenic is a naturally occurring element in soil and many rocks, especially those containing lead or copper, and it is distributed widely throughout Earth's crust. Arsenic is ordinarily a steel grey metal-like material when found in its elemental form; however, arsenic is typically found in the environment combined with other elements. These arsenic compounds often form white or colorless powders that do not evaporate and have no odor or flavor. Arsenic cannot be destroyed in the environment, but it can change form by reacting with other elements, by getting dissolved in water, or by the action of some bacteria. (7)

Since arsenic is so widely distributed and found naturally in the environment, individuals are typically exposed to arsenic through ingestion and inhalation by eating food, drinking water, incidental ingestion of soil, or breathing air. Some arsenic can also be absorbed through the skin. However, the amount of arsenic absorbed through the skin is usually small compared to the amount ingested or inhaled, so absorption through the skin is usually not a concern. (7)

Human studies have provided clear evidence that inhalation or ingestion of arsenic increases the risk of cancer. Long-term oral exposure to some arsenic compounds can cause changes in skin pattern which may cause darkening of the skin and the appearance of small "warts" or "corns" on the palms, soles, and torso. A small number of these corns may develop into skin cancer. (7)

Non-cancer effects of ingesting or inhaling arsenic may include: fatigue, abnormal heart beat, and impaired nerve function causing a "pins and needles" feeling in hands and feet. Concentrations of some arsenic compounds as low as 0.3 to 30 ppm in food or water may cause stomach irritation and cause stomachache, nausea, vomiting, and diarrhea (7). It is not known at this time exactly what form or forms of arsenic are present in Washington County; however, incidental ingestion of the arsenic compounds found in soils in Washington County is not anticipated to cause these sorts of outcomes.

Barium

Barium is a silvery-white metal that is found in ores containing mixtures of elements. When combined with other chemicals such as sulfur or oxygen, it forms barium compounds. These compounds are used to make paint, bricks, ceramics, glass, rubber, and other products. Barium compounds are also used by the oil and gas industries to make drilling mud that makes it easier to drill through rock by keeping the drill bit lubricated. (8)

The health effects of the different barium compounds vary depending on how well the compound dissolves in water or in the stomach. Barium compounds that do not dissolve well, such as barium sulfate, are generally not harmful. In fact, doctors sometimes use barium sulfate when performing some medical tests and taking x-rays of the gastrointestinal tract. (8)

Barium has not been shown to cause cancer in humans. The EPA has determined that barium is not likely to be carcinogenic to humans following ingestion and that there is insufficient information to determine whether it will be carcinogenic to humans following inhalation exposure. (8)

Barium is sometimes found naturally in drinking water and food. The barium compounds that are usually found naturally do not dissolve or mix well with water, so the amount of barium found occurring in drinking water naturally is usually small. Certain foods, such as brazil nuts, seaweed, fish, and some plants, may contain high concentrations of barium, but the concentration is not usually enough to be a health concern. (8)

Because the concentration of barium detected in three private drinking water wells exceeded MCLs, EPA has provided these residents with bottled water. Residential yards were not typically sampled for barium**.** However, the form of barium mined in Washington County was barite (barium sulfate), which is not readily dissolved by water and is not likely to cause harmful health effects.

Cadmium

Cadmium is a soft, silver-white metal that occurs naturally in the earth's crust. Cadmium is not usually present in the environment as a pure metal, but as a mineral combined with other elements. It is most often present in nature as complex oxides, sulfides, and carbonates in zinc, lead, and copper ores. Cadmium has many industrial uses and is used in consumer products including batteries, pigments, metal coatings, plastics, and some metal alloys. (9)

The exposure route of concern for cadmium in Washington County is ingestion of contaminated drinking water. Ingestion of high levels of cadmium in contaminated food or water can severely irritate the stomach, leading to vomiting and diarrhea, and sometimes death (9). Cadmium is a cumulative toxicant and ingestion of lower levels for a long period of time can lead to a buildup of cadmium in the kidneys and, possibly, kidney damage (9). The kidney is the main target organ for cadmium toxicity following chronic-duration exposure by oral routes (9). The EPA has classified cadmium as a probable human carcinogen by inhalation based on limited evidence of an

increase in lung cancer in humans and evidence of lung cancer in rats (9). Studies on humans and animals ingesting cadmium have not found increases in cancer, although additional research is needed (9).

Because one private well was found above MCL for cadmium, EPA has provided bottled water to individuals using that well. Residential yard soils were not sampled for cadmium.

Lead

Lead is a naturally occurring metal found in the earth's crust (10). It has no characteristic taste or smell (10). It is mined and processed for use in various industries. The practice of depositing mine tailings above ground has made a large volume of lead more accessible to people. Lead is used in some types of batteries, ammunition, ceramic glazes, medical equipment, scientific equipment, and military equipment (10). At one time, lead was used as an additive in gasoline and in paint. Lead from gasoline was released into the air in automotive exhaust and deposited along roadways (10). Houses built before 1978 may contain lead based paint. Lead in the soils in the inner cities is often attributable lead based paint and leaded gasoline (10).

Lead has no nutritional benefits for humans. Exposure to lead can occur by inhalation or ingestion. Lead is not readily absorbed through the skin, so dermal contact is not an important route of exposure. Lead has the greatest effect on the nervous system, especially in children. Pregnant women can experience complications with their pregnancy ranging from low birth rate to miscarriage if exposed to high concentrations of lead. (10)

Studies have shown that there is a definite correlation between concentrations of lead in soils and blood lead levels in children. In general, blood lead levels increase as the lead concentrations in soil and dust increase. As blood lead levels increase, the likelihood of adverse health effects also increases. Examples of adverse health effects of children exposed to lead include learning difficulties and behavioral problems.

Lead Cleanup for Soil

ATSDR has not developed a MRL for human exposure to lead, nor has the EPA developed a RfD. Therefore, the usual approach of estimating human exposure to an environmental contaminant and then comparing this dose to a health guideline (such as an MRL or RfD) cannot be used. Instead, exposure to lead is evaluated by using a biological model that predicts a blood lead concentration that would result from exposure to environmental lead contamination. The modeled blood lead concentration is then compared to the level of concern for blood lead concentrations in children as recommended by the Centers for Disease Control and Prevention (CDC) (CDC, 2005). CDC's current level of concern is10 micrograms of lead per deciliter of blood (10 µg/dL). (13) Using this model, EPA has established a standard cleanup value of 400 parts per million (ppm) for lead in soil using the default parameters in this model (14). The default parameters in the model include many estimated values such as estimated soil ingestion and time spent outdoors. If the default parameters are found to not be accurate in an area being investigated, the cleanup value used at that site may be different.

In addition to the standard cleanup value, EPA typically develops another lead concentration for large sites to prioritize which residential yards need to be remediated first. Residential yards with concentrations above this value are called time critical yards. For Washington County, EPA has set 1,200 ppm as the time critical removal action level. Residential yards with lead concentrations of 400 ppm or greater are also considered time critical if a child with a blood lead level of 10 µg/dL or greater resides there.

The default parameters used in the model may not take into consideration all of an individual's exposure to lead. An individual can be exposed to lead through many sources such as drinking water, lead paint, and other items containing lead including certain toys, jewelry, herbal remedies, Mexican candies, water hoses, and others.

The lead concentrations found in the soil and water in Washington County exceed site-specific EPA lead action levels. Residents, especially children, who are exposed to lead contaminated soil or water, may be at risk for adverse health effects. Because the concentration of lead detected in a large number of private drinking water wells exceeds the site specific action level, EPA has provided these residents with bottled water. EPA is also currently conducting time-critical removal actions at a large number of residential yards throughout Washington County.

Cancer

While the EPA considers lead to be a probable human carcinogen and the National Toxicity Program (NTP) has determined that lead and lead compounds are reasonably anticipated to be human carcinogens, there have been no studies linking residential ingestion of lead contaminated soil or drinking water with an increase cancer risk (10, 11). Although the American Cancer Society estimates less than half of men and slightly more than a third of women in the United States will develop some form of cancer in their lifetime, the primary health concern for lead in Washington County is not cancer; instead, the primary concern from exposure to lead in Washington County is the effects lead has on the nervous system, especially on children less than 72 months of age (12).

Children's Health

In general, children are more likely than adults to become exposed to contaminants in soil or water. In their daily activities, children have a tendency to have frequent hand-to-mouth contact and introduce non-food items into their mouths. Because children are smaller and their bodies typically retain more of the contaminants, it usually takes less of a contaminant to cause adverse health effects in children than adults.

The effects of exposure to arsenic on children are expected to be similar to the effects on adults. Children are exposed to arsenic in many of the same ways adults are and exhibit similar symptoms. In addition to symptoms that occur in adults, exposure to arsenic may result in children having lower IQ scores or exposure to arsenic may injure pregnant women or their unborn babies. Because children tend to eat and drink less of a variety of foods and drinks than adults, ingestion of a food, juice, or baby formula containing arsenic may have a larger impact on

them. Children can be exposed to arsenic by coming into contact with clothing contaminated with arsenic especially if the parents have jobs or hobbies that use arsenic or products containing arsenic. (7)

It is not known whether children are more or less sensitive to the health effects caused by barium exposure. People who ingest elevated levels of barium may experience gastrointestinal disturbances, such as vomiting, abdominal cramps, diarrhea. Exposure can also cause difficulties in breathing, increased or decreased blood pressure, numbness around the face, and muscle weakness. (8)

The effects of exposure to elevated cadmium levels on children are expected to be similar to the effects on adults. Ingestion of high levels of cadmium in contaminated food or water can severely irritate the stomach, leading to vomiting and diarrhea, and sometimes death. Ingestion of lower levels of cadmium over an extended period of time can lead to buildup in the kidneys, and possibly, kidney damage. (9)

Children are more susceptible to lead poisoning than adults, and children are also more likely to be exposed to lead contaminated materials. Infants and young children can swallow and breathe lead in dirt, dust, or sand while they play on the floor or ground. Also, compared to adults, a larger proportion of the amount of lead swallowed will enter the blood in children (10). While about 99% of the amount of lead taken into the body of an adult will leave as waste within a few weeks, only about 32% of lead taken into the body of a child will leave as waste (10). All of these factors result in children being more affected by lead than adults when they have similar lead concentrations in their environment.

When children are exposed to lead contaminated materials, a variety of adverse health effects can occur depending on the amount of lead to which they are exposed and the duration of exposure. These effects include learning disabilities, slowed growth, hyperactivity, impaired hearing, and at very high exposure levels, even brain damage (10). Lead has the greatest effect on the nervous system, especially in children. In children, low levels of lead can cause weakness in fingers, wrists, or ankles. Unborn children can also be exposed to lead through their mothers and are at risk of premature births, low birth weight, decreased mental ability, learning difficulties, and reduced growth as young children (10).

Yearly blood-lead testing before a child is 72 months old is key to determining if the child has been exposed to lead. Eliminating exposure pathways by controlling contamination sources, practicing good personal hygiene, and eating a proper diet high in calcium can reduce the risk of lead poisoning in children.

Children who exhibit pica behaviors may be at an even greater risk of becoming exposed to contaminants in soil than other children. Individuals who exhibit pica behaviors have a craving to put non-food items in their mouth or eat non-food items, such as dirt, paint chips, sand, etc. Children exhibiting pica behavior in Washington County may be more likely to experience adverse health effects from lead, barium, and arsenic found in the soil and should be seen by a physician.

CONCLUSIONS

Past mining activities have resulted in elevated lead concentrations in soils throughout the mining areas in Washington County, Missouri. Because of the widespread contamination of recreational areas, residential yard soils, and private drinking water wells, residential and recreational exposure to elevated concentrations of lead is likely. Because of these multiple exposure pathways, this site is considered to be a *Public Health Hazard* for Washington County residents for past, present and future exposure. A site that is classified as a public health hazard poses a health risk as a result of long-term exposures to hazardous substances. This classification is based on the following conclusions:

1. Residential yards throughout the mining areas of Washington County contain lead in soil at concentrations above a level of health concern.

2. Private drinking water wells throughout the mining areas of Washington County have been found to contain lead at concentrations above a level of health concern for lead in drinking water.

RECOMMENDATIONS

1. EPA/MDNR should continue with efforts to get the Potosi, Richwoods, and Old Mines operable units listed on the National Priorities List.

2. EPA/MDNR should continue with efforts to permanently eliminate exposure to lead-contaminated residential yard soils and private drinking water wells.

3. EPA should continue to provide bottled water to residents with contaminated private drinking water wells until a permanent solution can be reached.

4. EPA/MDNR should extend their sampling to outside the three operable units in Washington County.

5. ATSDR/DHSS/Washington County Health Department should provide health education to the residents of Washington County to inform them of the importance of having their residential yard soils and private drinking water tested for lead.

6. ATSDR/DHSS/Washington County Health Department should continue to encourage residents of Washington County to have yearly blood lead testing conducted for children less than 72 months of age and expectant mothers.

7. ATSDR/DHSS/Washington County Health Department should provide health education to the residents of Washington County about how to reduce their exposure to metals in soils and drinking water with emphasis being on lead.

8. ATSDR/DHSS should create Public Health Assessments for the operable units in Washington County when the operable units are placed on the National Priorities List.

PUBLIC HEALTH ACTION PLAN

The Public Health Action Plan (PHAP) for the Washington County Lead District contains a description of actions to be taken by the Missouri Department of Health and Senior Services (DHSS), the Agency for Toxic Substances and Disease Registry (ATSDR), and other involved parties. The purpose of the PHAP is to ensure that this health consultation not only identifies public health hazards, but provides an action plan to mitigate and prevent adverse human health effects resulting from past, present, and future exposures to contamination. Included is a commitment from DHSS and/or ATSDR to follow up on this plan to ensure that it is implemented.

1. DHSS/ATSDR will work with the Washington County Health Department to provide health education and blood lead screening for the residents of Washington County.

2. DHSS/ATSDR will coordinate with MDNR and EPA to address community health concerns and questions as they arise and provide necessary community and health professional education.

3. DHSS/ATSDR will coordinate with MDNR and EPA to implement the recommendations in this public health consultation.

4. DHSS/ATSDR will update this public health consultation as needed.

5. DHSS/ATSDR will create Public Health Assessments for the operable units in Washington County once the operable units are placed on the National Priorities List.

CERTIFICATION

The Missouri Department of Health and Senior Services (DHSS) prepared this Washington County, Missouri, health consultation under a cooperative agreement with the federal Agency for Toxic Substances and Disease Registry (ATSDR). It was completed in accordance with the approved methodologies and procedures existing at the time the health consultation were initiated. The Cooperative Agreement partner completed editorial review.

Technical Project Officer, CAT, CAPEB, DHAC

The Division of Health Assessment and Consultation (DHAC), ATSDR, has reviewed this health consultation and concurs with its findings.

Team Lead, CAT, CAPEB, DHAC, ATSDR

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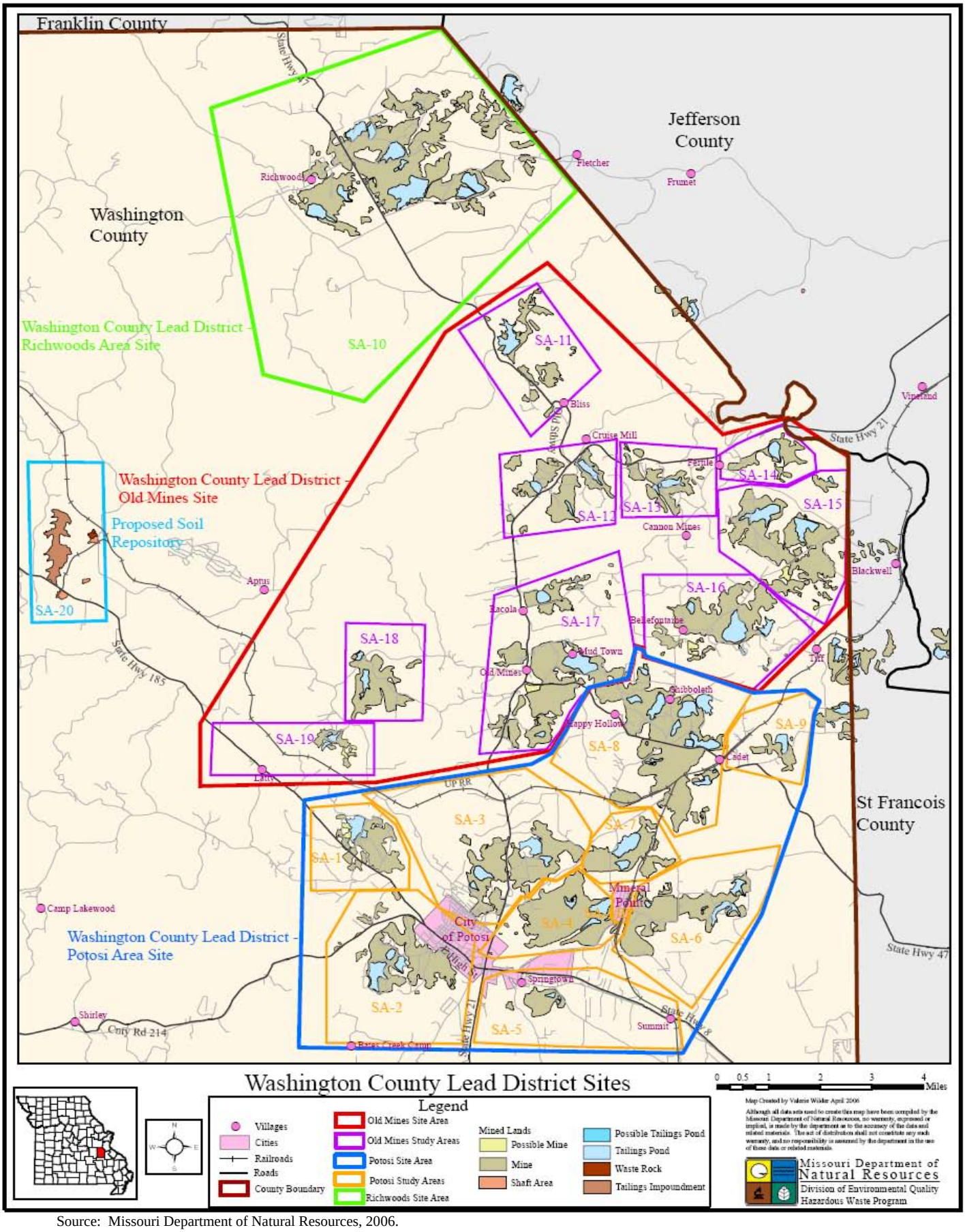
Attachments: Figure 1: Designated EPA Areas in Washington County

Figure 1

Designated EPA Areas in Washington County



Source: Missouri Department of Natural Resources, 2006.